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THEATER BALLISTIC MISSILE DEFENSE

OPERATING FORWARD FROM THE SEA

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The proliferation of weapons of mass destruction and the ballistic missiles used to employ them pose the greatest security challenge to the U.S. and her allies. In the past, active defense measures taken to combat the ballistic missile threat were concentrated on launch platform destruction or use of ground-based ballistic missile defense assets. In an era of declining overseas bases, limited strategic lift capability, and the Army and Air Force operating in an expeditionary role, naval forces will usually be the first units to respond to a crisis. Therefore, sea-based ballistic missile defense is a necessity. This paper provides an overview of the Navy?s theater ballistic missile defense program. Specifically, it addresses the relationship between ballistic missiles and developing nations. It provides some background on the Joint Theater Missile Defense framework and the active defense programs being developed to support that framework. Most of the paper discusses the advantages of sea-based ballistic missile defense along with the Navy?s two solutions to the ballistic missile threat, Navy Area Defense and Navy Theater-Wide Defense. At the turn of the century, the Navy will field a robust theater ballistic missile defense capability, centered on Aegis surface combatants, that is mobile, flexible, sustainable and cost effective.

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Abstract

The proliferation of weapons of mass destruction and the ballistic missiles used to employ them pose the greatest security challenge to the U.S. and her allies. In the past, active defense measures taken to combat the ballistic missile threat were concentrated on launch platform destruction or use of ground-based ballistic missile defense assets.

In an era of declining overseas bases, limited strategic lift capability, and the Army and Air Force operating in an expeditionary role, naval forces will usually be the first units to respond to a crisis. Therefore, sea-based ballistic missile defense is a necessity.

This paper provides an overview of the Navy's theater ballistic missile defense program. Specifically, it addresses the relationship between ballistic missiles and developing nations. It provides some background on the Joint Theater Missile Defense framework and the active defense programs being developed to support that framework. Most of the paper discusses the advantages of sea-based ballistic missile defense along with the Navy's two solutions to the ballistic missile threat, Navy Area Defense and Navy Theater-Wide Defense.

At the turn of the century, the Navy will field a robust theater ballistic missile defense capability, centered on Aegis surface combatants, that is mobile, flexible, sustainable and cost effective.

Chapter 1

Introduction

Background

As the next century approaches, the United States is facing a world of uncertainty. For nearly three decades the Cold War symbolized peace and stability through a policy of mutually-assured destruction. The passing of this era has produced a less predictable enemy and an even less stable strategic environment. The 1995 National Security Strategy as articulated by the President of the United States recognizes four principal dangers which our military, in concert with other instruments of power, must address: regional instability, the proliferation of weapons of mass destruction (WMD), transnational dangers and the dangers to democracy and reform.[1]

The proliferation of WMD and the ballistic missiles used to employ them pose the greatest security challenge to the U.S. and her allies. Ballistic missile technology is pervasive in the global market. Most of the emerging threats are Scud missile variants, which operate in the 80-600 kilometer range. According to Lt Gen O'Neill, the current ballistic missile threat "is largely regional in nature but the trend is clearly in the direction of increasing range, lethality, accuracy and sophistication."

Traditionally, active defense measures that have been implemented to counter the ballistic missile threat have focused predominantly on destroying the launch platform or using ground-based ballistic missile defense assets such as the Army's Patriot system. However, in an era of declining overseas bases, limited strategic lift capability, and the Army and Air Force operating in an expeditionary role, naval forces will usually be the first units to respond to a crisis. This paper examines the requirement for a versatile sea-based ballistic missile defense capability.

Research Scope

The ballistic missile threat and the proliferation of WMD in developing nations present the challenge that ground-based and sea-based theater ballistic missile defense forces are facing. Weapons of mass destruction are not discussed in great detail, however, the assumption is made that nations will always try to acquire more lethal weapons. In addition to an overview of the ballistic missile threat, the primary focus of Chapter Two is who has these weapons and why they wish to procure them.

The Joint Theater Missile Defense (TMD) framework is discussed with respect to the four operational tenets along with a description of the two areas that make up the upper and lower tier in the theater missile defense (TMD) environment. Chapter Three concludes with a brief description of the Ballistic Missile Defense Organization's (BMDO) core and advanced concept programs. The intent here is to give the reader a feel for the individual TBMD systems and how they are integrated within the joint framework.

Chapter Four is the primary focus of this project. It provides an in-depth examination of the advantages of sea-based defense. Much of the work that has been accomplished

within the Navy TBMD area is either classified or the level of detail is beyond the scope of this study. Because of this, the remaining portion of this chapter provides an overview of the major components of the program such as: tracking events, Navy Area Defense, Navy Theater-Wide Defense, and the Navy's command and control (C2) architecture. This chapter should convince the reader that sea-based TBMD is a necessity, that Aegis surface combatants are a logical and cost effective means of employing the TBMD capability, and that the Navy TBMD program is prepared to support the Joint TMD framework.

Notes

[1] Chairman of the Joint Chiefs of Staff, *National Military Strategy of the United States*, 1995, 2.

Chapter 2

Nature of the Threat

It remains, nevertheless, an ingenious and diabolical robot conception translated into fact. It belongs to a world of hideous phenomena. It comes without sound, without warning and without discrimination. Its inaccuracies are so vast that it becomes a weapon of monstrous chance, neither aeronautic nor military in its value and power.

—Flying Officer H.E. Bates

Ballistic Missiles and the Strategic Environment

The use of ballistic missiles in war and conflict is nothing new. On the night of June 12, 1944, the first V-1 rocket-propelled bomb struck England. In a three month period, 5,890 flying bombs landed in England, killing 5,835 persons and seriously injuring another 16,762. The allies initiated Operation CROSSBOW which used the strategic air forces to try and stem the V-1 attacks. Seventy-seven days and 16,566 sorties after Operation CROSSBOW had commenced, the V-1 attacks continued unchallenged.[1] By the fall of 1944 the Germans had initiated their V-2 campaign. The V-2 offensive lasted from September 8, 1944 to March 27, 1945. During this six month period, 518 V-2s struck England inflicting an additional 21,000 casualties.[2] The strategic air force's effectiveness at bombing V-2 launch platforms was not much better. The world had witnessed the advent of the ballistic missile and a turning point in the history of warfare.

More recent uses of ballistic missiles were demonstrated in the eight year Iran-Iraq War and the Gulf War. In each of these conflicts, belligerents used ballistic missiles to attack both military and civilian targets. The Iraqi Scud missile is essentially a 50-year old derivative of the German V-2 rocket. During the Gulf War, 28 U.S. service men and women were killed and approximately 100 wounded when a single Scud missile struck their barracks.[3] The parallel between the British experience with V-2 attacks in World War II (WWII) and the U.S. experience with Scud missile attacks in the Gulf War is clear, "in the absence of effective active defenses, attacks by relatively limited numbers of operationally unreliable and inaccurate missiles armed with conventional high-explosive warheads can have major adverse strategic effects on the country under attack, especially psychologically."[4] Ballistic missiles, which proved to be an effective terror weapon in WWII, are still effective 50 years later.

Developing Nations and Ballistic Missiles

Recent world events underscore the seriousness of ballistic missile proliferation. The Gulf War reminded us of some historical lessons about the political and military value of ballistic missiles. First, Iraq demonstrated that conventionally armed ballistic missiles can be used to weaken fragile coalition ties, influence military strategy, political options and public opinion, just as Hitler was able to influence allied forces and private citizens in Europe.[5] Second, relying on Cold War methods of deterrence may not work in third world regional conflicts. Some nations may attempt to follow China's example and use ballistic missiles as a form of international blackmail or strategic intimidation.[6] Finally, just as in Operation CROSSBOW, the Gulf War coalition forces were not able to locate and

destroy the vast numbers of mobile missile launchers or preempt offensive ballistic missile attacks.[7]

Today, only China and Russia possess the capability to strike the continental U.S. with ballistic missiles. The U.S. intelligence community considers a near-term, deliberate attack by either country very unlikely. However, Russia's economic and military instability is cause for concern. In an attempt to bolster a faltering economy, the Russians have resorted to supplying developing nations with ballistic missile technology.[8]

Currently there are no nations, the U.S. considers hostile, that are capable of threatening the continental U.S. with ballistic missiles. However, defense analysts believe the North Korean Taep'o Dong 2's potential operating range could place Hawaii and Alaska in jeopardy by the year 2000.[9] Table 1 shows the ballistic missile capabilities of developing countries.

Table 1. Developing Countries and Ballistic Missiles

Afghanistan	Scud B	North Korea	Scud B, Scud C No Dong 1
Argentina	Alacran, Condor 2		Taep'o Dong 1 Taep'o Dong 2
Brazil	MB/EE-150, SS-150 MB/EE-300, SS-300 MB/EE-600 MB/EE-1000 SS-1000	Pakistan	Hatf 1, Hatf 2 M-11
		Saudi Arabia	CSS-2
China	B-610, M-11, M-9 CSS-2	South Africa	Arniston
Egypt	Scud B, Scud C Vector, FROG	South Korea	NHK 1, NHK 2 Lance, NHK-A
India	Prithvi, Agni	Syria	SS-21, Scud B Scud C, M-9, FROG
Iran	Scud B, Scud C	Taiwan	Green Bee Sky Horse
Iraq	Scud B, Scud C Al Hussein Al Abbas, FROG	Vietnam	Scud B
Israel	Lance, Jericho 1 Jericho 2B	Yemen	SS-21, Scud B
Libya	SS-21, Scud B Scud C, M-9 Al Fatah		

Source: Dr. Keith B. Payne, "Ballistic Missile Proliferation: A Quick-Look Summary," March 1997, *CDISS*, on-line, America On-line, March 1997

Ballistic missiles are appealing weapons for developing nations. In many instances they are seen as status symbols that can be used to project power against a stronger opponent. Their long range, short flight time, immunity to interception, relatively low cost, and ability to carry a wide variety of warheads offer unique political as well as military advantages. Ballistic missiles do not require skilled pilots nor are their mobile launch sites subject to potential counter strikes.[10] Table 2 shows the frequency of ballistic missile use in regional conflicts.

Table 2. Ballistic Missile use in Regional Conflict

Conflict	Date	Missile	Used By	Used Against
Yom Kipper War	1973	Scud FROG	Egypt Egypt/Syria	Israel Israel
Iran-Iraq War	1980-1988	Scud FROG	Iran/Iraq Iraq	Iraq/Iran Iran
U.S.-Libya	1986	Scud	Libya	Italy
Afghanistan	1988-1991	Scud	Afghanistan	Afghan Rebels
Desert Storm	1991	Scud FROG	Iraq Iraq	U.S. Forces, Israel, Saudi Arabia, Qatar, Bahrain
Yemen Civil War	1994	Scud	Yemen	Yemen
China-Taiwan	1996	M-9	China	Taiwan Coast

Source: "Ballistic Missile Threats: An Introduction," March 1997, *CDISS*, on-line, America On-line, March 1997

Developing nations possess over a dozen families of ballistic missiles. Patterns of proliferation vary. Many nations import their weapons because they lack the skilled personnel and capital necessary to develop a ballistic missile program. Other countries have imported the knowledge and technology required to start an indigenous weapons program. For example, the ballistic missile programs that emerged in the U.S. and Russia immediately following WWII can be linked to German scientists who had worked on the V-2 program. More recently, development of North Korea's Taep'o Dong program can be traced to Russian experts that helped design the Scud missile. Finally, some countries are purchasing weapons and modifying them, with the assistance of the supplying nation to meet their needs.[11]

The Conference Report of the 1996 Defense Authorization Act stated that the trend in missile proliferation is toward longer range and more sophisticated ballistic missiles,

including weapons of mass destruction (nuclear, biological and chemical). More than 25 nations may have or are developing WMD and the means to employ them. Many nations still wish to possess nuclear devices, no matter how crude. However, chemical weapons have become the weapon of choice for most developing nations. These weapons are viewed as an affordable alternative to nuclear weapons. Biological weapons are not as popular as chemical weapons simply because they are more difficult to develop and harder to maintain.[12]

In 1991, the Under Secretary of the Navy for Research, Development and Acquisition initiated a series of studies to determine the benefits of sea-based TBMD.[13] In December 1992, the Joint Requirements Oversight Council (JROC) validated the need for a sea-based theater ballistic missile defense (TBMD) capability. In 1994, the Chief of Naval Operations directed the establishment of a Navy TBMD organization to develop a near-term solution encompassing Aegis cruisers and destroyers and a supporting Battle Management/Command, Control and Communications (BM/C3) system.

Notes

[1] Richard G. Davis, *Carl A. Spaatz and the Air War in Europe* (Center for Air Force History, 1993), 426-430.

[2] "The German V-2 Campaign, 1944-45," March 1997, *CDISS*, on-line, America On-line, March 1997.

[3] Lt Gen Lester L. Lyles, "Role of Missile Defense in U.S. National Security Strategy," address to the U.S. Army Symposium on Strategy, Force Structure and Defense Planning for the 21st Century, November 1996.

[4] "The German V-2 Campaign, 1944-45," March 1997, *CDISS*, on-line, America On-line, March 1997.

[5] Secretary of Defense, Annual Report to the President and the Congress, (Washington, D.C.: U.S. Government Printing Office, 1995), 241.

[6] Ibid.

[7] Ibid.

[8] Joseph C. Anselmo, "U.S. Faces Growing Arsenal of Threats," *Aviation Week & Space Technology*, 24 February 1997, 46.

Notes

[9] Dr. Keith B. Payne, "Ballistic Missile Proliferation: A Quick-Look Summary," March 1997, *CDISS*, on-line, America On-line, March 1997.

[10] "Ballistic Missile Threats: An Introduction," March 1997, *CDISS*, on-line, America On-line, March 1997.

[11] "Patterns of Ballistic Proliferation," March 1997, *CDISS*, on-line, America On-line, March 1997.

[12] "BMDO Fact Sheet 96-009, Ballistic Missiles and the World Security Environment," February 1996, *Ballistic Missile Defense Organization Link*, on-line, America On-line, January 1997.

[13] "Aegis Supports Ballistic Missile Defense Mission," *Naval Forces, Aegis Special Supplement* 17, no. 2 (February 1996): 19.

Chapter 3

Theater Missile Defense Overview

> *…we received a report that a Scud fired at Dhahran had struck a U.S. barracks. The explosion killed twenty-eight of our troops and wounded many more. It was a terrible tragedy—this terror weapon launched into the sky that by sheer fate happened to fall where we had concentrated our troops—and it brought home once again to our side the profanity of war. I was sick at heart.*
>
> —General H. Norman Schwarzkopf

Theater Ballistic Missile Defense Framework

The decision to reorient the ballistic missile defense program focus was partially due to coalition forces inability to preempt Scud missile attacks during the Gulf War. As a result, the Ballistic Missile Defense Act of 1991 was implemented. This legislation outlined U.S. goals with respect to ballistic missile defense and provided the foundation for what is commonly referred to as the "Four Pillars of Theater Ballistic Missile Defense" or the "Four Operational Tenets of Joint Theater Missile Defense." The four tenets are: passive defense, active defense, attack operations, and command, control, communications, computers and intelligence (C4I).

Passive Defense

These actions or capabilities are necessary to minimize the effects of a ballistic missile attack, but do not actually involve engaging the enemy. Passive defense is designed to

provide collective protection for friendly forces and their equipment, population centers, air bases, seaports and fleet operating areas. Passive defense enhances survivability and reduces vulnerability through measures such as: tactical warning, reducing targeting effectiveness, minimizing vulnerability, and recovery and reconstitution. First, tactical warning is the means of alerting units that an attack is imminent or in progress. Disseminating the predicted impact point and number of inbound missiles is especially critical here. Second, enemy targeting effectiveness can be reduced by ensuring proper operational security procedures are followed and influencing enemy intelligence assets through deception. Third, the effects of attacks can be minimized by duplicating critical capabilities and hardening facilities where critical assets are stored or operate routinely. Finally, units must be able to be restored to a specified level of combat effectiveness in a reasonable period of time.[1]

Active Defense

Active defense operations are designed to protect forces and critical assets from attack by engaging airborne TBMs or their launch platforms. This is the mission of Navy TBMD. The purpose of active defense is to provide defense-in-depth. This concept creates multiple opportunities to engage TBMs at various points along their flight path. Defense-in-depth reduces the possibility of leakers, increases the probability of kill and prevents the enemy from countering a particular system with a single technique.[2]

Attack Operations

Attack operations are offensively oriented and intended to destroy or disrupt enemy TBM capabilities before, during, and after a TBM launch. Destruction prior to launch is

the preferred method of countering enemy TBM operations, although in the past it has proved quite difficult. To conduct effective attack operations, a thorough understanding of the enemy's TBM infrastructure is necessary. Intelligence preparation of the battlespace is critical.[3] The Gulf War is an example of the importance that intelligence plays in attack operations. Even with the large amount of resources dedicated to locating Iraqi Scud missile launchers, coalition forces were still not able to preempt the attacks.

Command, Control, Communications, Computers and Intelligence

The command, control, communications, computers and intelligence (C4I) system provides the synergism required to support the Joint TMD framework. First, this system provides the tactical warning, threat identification and predicted impact point for passive defense. Second, it is used to cue upper and lower tier TBMD systems for active defense. Finally, it supports attack operations through intelligence collection to determine TBM launch points. It also provides rapid transmission of targeting data and battle damage assessment.[4]

Missile Defense Today

In 1993 the Strategic Defense Initiative Office was renamed the Ballistic Missile Defense Office (BMDO). This change acknowledged a fundamental shift in the strategic environment during the previous three years.. The policy of mutually-assured destruction as a means of resolving conflicts was losing favor. Greater emphasis was being placed on the proliferation of WMD while developing and fielding advanced theater ballistic missile defenses to combat this proliferation. This refocusing of the missile defense mission was a result of the 1993 Department of Defense Bottom-Up Review.

Theater Missile Defense Environment

The theater missile defense environment is separated into two tiers, an upper and lower. These areas are defined by the apogee of the TBM, its speed, the speed of the interceptor, and the altitude at which intercept takes place. Upper tier systems are designed to engage TBMs in the exoatmosphere (80-100 km) or beyond the earth's atmosphere. These missiles are usually in the late midcourse portion of flight. Lower tier systems are designed to engage TBMs in the endoatmosphere or within the earth's atmosphere. These targets are usually in the terminal phase of flight. The Joint TMD concept capitalizes on defense-in-depth, which provides multiple opportunities to engage a target as it passes through each of the tiers. Although some systems, such as the Theater High Altitude Air Defense (THAAD), can operate in both tiers, most TBMD systems are designed to operate in a single tier.[5] Technology limitations are the primary reason TBMD systems are designed for specific tiers. For example, systems that operate in the lower tier typically use blast fragmentation warheads which are not suitable for exoatmospheric intercepts.

Theater Ballistic Missile Defense Programs

There are six systems in various stages of operation or development designed to engage TBM threats. The THAAD system, Navy Theater-Wide Defense (NTWD) and Airborne Boost-Phase Intercept (BPI) operate in the upper tier. The Patriot Advanced Capabilities-3 (PAC-3), Navy Area Defense and the Medium Extended Air Defense System (MEADS) operate in the lower tier. The THAAD, Navy Area Defense and PAC-3 are TMD core programs while NTWD, MEADS and BPI are advanced concept

programs.[6] The core programs are those systems that will be deployed in the near-term to meet the ballistic missile threat. The primary differences between the core programs and the advanced concept programs are the amount of funding each has received, the maturity of the technology required to support a specific system and the time before each system will be deployable. The core programs and advanced concept programs are discussed below.

Core Programs

Theater High Altitude Air Defense (THAAD). The THAAD system is composed of a weapon system element and a TMD-Ground Based Radar (TMD-GBR) surveillance radar system element. The centerpiece of the core TMD systems, THAAD, is designed to engage the entire spectrum of TBM threats and is capable of operating in the exoatmosphere and endoatmosphere. THAAD is intended to perform long range, high altitude intercepts to minimize the effects of TBM debris and allow multiple opportunities for engagement.[7]

The THAAD missile is a single stage, solid fuel missile. Like most systems capable of operating in the exoatmosphere or upper endoatmosphere, the missile has a divert attitude control system and uses thrust vector technology. The TMD-GBR maintains track on the inbound target and provides predicted intercept points and midcourse guidance updates. The THAAD missile uses an infrared seeker for terminal homing and a kinetic kill vehicle (KKV) (hit-to-kill) to destroy inbound warheads.[8]

The TMD-GBR is a mobile, single faced, X-band, phased array antenna that provides early warning of TBM launches. The GBR is capable of providing long range, theater-wide surveillance, target discrimination and classification, reentry vehicle identification,

fire control for the weapon system and data for kill assessment. This system will complete the near term defense-in-depth capability by operating primarily in the upper tier, while cueing lower tier systems such as, Patriot or Navy Area Defense.[9]

Navy Area Defense. Navy Area Defense will provide sea-based area TBMD capability expanding on the existing Aegis Weapon System (AWS). The Navy has modified the AWS, including the Standard Missile SM-2, to enable TBM detection, tracking and engagement. When deployed in fiscal year 1998, the AWS will be capable of detecting TBMs through autonomous search, cueing from other ships or remote cues from national level sensors.[10]

The Aegis radar (SPY) computer program has been modified to allow detection and tracking at higher elevations and longer ranges to support the TBMD mission. The Weapon Control System (WCS) will predict intercept points, determine engagement boundaries, schedule launches, launch missiles and uplink midcourse guidance commands to the missile via the SPY radar, similar to a normal surface to air engagement sequence. The Command and Decision (C & D) system and the Aegis Display System (ADS) will be modified to display TBM track information and engagement symbology and to report that information over tactical data links such as Link-11 and Link-16.[11]

Patriot Advanced Capabilities - 3 (PAC-3). The Patriot is an area defense system capable of intercepting TBMs in the terminal phase of flight. Designed as an air defense system, the Patriot has received a series of successive improvements since its initial deployment in 1985 and will culminate with the PAC-3 Configuration 3 system in 1999.[12]

The PAC-1 system was fielded in 1988 which provided the initial TBMD capability. The PAC-2 system made its battlefield debut during the Gulf War in 1990. Gulf War

experiences resulted in the Patriot Quick Response Program (QRP). This intermediate system provided better sensing equipment and a remote launch capability.[13]

The PAC-3 Configuration 1 system provides improved battle management, command, control, communications and intelligence. It also incorporates the Guidance Enhanced Missile (GEM). The prominent change in the Configuration 2 system is a better classification, discrimination and identification capability. The Configuration 3 system will offer a number of improvements. This system will feature the Extended Range Interceptor (ERINT) missile in conjunction with GEM. The ERINT missile uses hit-to-kill technology and eliminates the short intercept ranges characteristic of the PAC-2 missile.[14]

Advanced Concept Programs

Medium Extended Air Defense System (MEADS). MEADS, formerly Corps SAM, will provide low to medium altitude theater air defense against short-range ballistic missiles, cruise missiles, unmanned aerial vehicles, fixed and rotary wing aircraft.[15]

Navy Theater-Wide Defense (NTWD). The NTWD program will provide an upper tier, sea-based capability to counter TBM threats. This program builds on the Navy Area Defense program and the Standard Missile SM-2 Block IV to develop a Lightweight Exoatmospheric Projectile (LEAP). The LEAP should be deployed on Aegis surface combatants by the year 2005.[16]

Airborne Boost Phase Intercept (BPI). This program is still in concept development, but focuses on intercepting ballistic missiles during their most vulnerable portion of flight, the boost phase or ascending phase. This capability may serve as a deterrent to launch or may ensure the weapon is destroyed prior to submunition release, in order to minimize debris fallout on friendly territory.[17]

Notes

[1] Joint Pub 3-01.5, *Doctrine for Joint Theater Missile Defense*, February 1996, x, III-4.

[2] Ibid., x, III-7.

[3] Ibid., xi, III-10,11.

[4] Joint Pub 3-01.5, *Doctrine for Joint Theater Missile Defense*, February 1996, III-14,15.

[5] "BMDO Fact Sheet 96-001, U.S. Ballistic Missile Defense Program Focus," March 1996, *Ballistic Missile Defense Organization Link*, on-line, America On-line, January 1997.

[6] Ibid.

[7] Ballistic Missile Defense Organization, *1995 Report to the Congress on Ballistic Missile Defense*, 2-(26-28).

[8] Ibid.

[9] "Theater Missile Defense Ground Based Radar (TMD-GBR)," February 1996, *Ballistic Missile Defense Organization Link*, on-line, America On-line, February 1997.

[10] Program Executive Office, *Cost Analysis Requirements Description (Revision 3.0) for Navy Area TBMD*, April 1996, 6.

[11] Ballistic Missile Defense Organization, *1995 Report to the Congress on Ballistic Missile Defense*, 2-(23-24).

[12] "BMDO Fact Sheet 95-002, Patriot Advanced Capability (PAC-3)," August 1996, *Ballistic Missile Defense Organization Link*, on-line, America On-line, January 1997.

[13] Ibid.

[14] Ibid.

[15] Ballistic Missile Defense Organization, *1995 Report to the Congress on Ballistic Missile Defense*, 2-35.

[16] Ibid., 36.

[17] Lt Gen Malcolm R. O'Neill, "Ballistic Missile Defense: 12 Years of Achievement," Defense Issues 10, no. 37 (1995): 7.

Chapter 4

Navy Theater Ballistic Missile Defense

The ship is going to become a much more important part of the ground battle. Every soldier is going to hope an Aegis cruiser or Arleigh Burke-class destroyer is within 50 kilometers of the battle. He'll feel a lot safer. In the old days he could ignore the surface Navy. Now you are overhead protection until everyone gets on station.

—Lieutenant General Malcolm R. O'Neill
Director, BMDO

Defense from the Sea

In 1992 the Navy-Marine Corps publication, '…From The Sea', provided the strategic concepts that would guide the Navy into the 21st century. It marked a fundamental shift in operational focus and a change in strategic direction. Two hundred years of blue water warfighting were being replaced with brown water joint operations, operating from the sea.[1]

In 1994, "Forward…From The Sea" expanded on the strategic concepts previously articulated, and addressed the unique contributions naval forces offer with respect to forward presence, crisis response and regional conflicts. Historically, naval forces have been used as a means of preventive diplomacy or as part of a larger flexible deterrent option package. In the event diplomacy or deterrence fail, sea-based forces provide an immediate response capability and the "critical operational link between peacetime

operations and the initial requirements of a developing crisis or major regional contingency."[2]

The Army, Navy and Marine Corps will each eventually have the capability to provide protection of forward deployed forces within the Joint TMD active defense framework. Ground-based systems such as Patriot, THAAD and MEADS will provide the defensive capability, however, sea-based systems also offer certain capabilities and advantages.

Peacetime Forward Presence Operations

Forces stationed overseas and naval forces stationed abroad are the most visible indication of our commitment to regional interests.[3] As overseas bases continue to close and the services respond as continental U.S. based expeditionary forces, the U.S. will increasingly rely on naval forces to provide forward presence.

The President's 1996 National Security Strategy of Engagement and Enlargement emphasizes the critical importance of a credible overseas presence:

> …[presence] demonstrates our determination to defend U.S. and allied interests in critical regions, deterring hostile nations from acting contrary to those interests; provide forward elements for rapid response in crises as well as the bases, ports and other infrastructure essential for deployment of U.S. based forces by air, sea and land…[4]

Aircraft carrier battle groups and amphibious ready groups provide theater commanders with the capabilities to respond to a broad range of contingencies in a forward presence role. These forces arrive in theater trained and equipped for combat but are also capable of executing operations such as bilateral exercises and humanitarian assistance operations.[5]

Aegis cruisers and destroyers will offer a unique capability to traditional conventional deterrence. Armed with Tomahawk cruise missiles and Navy Area Defense missiles, these

surface combatants will play an important role in discouraging ballistic missile proliferation and the use of ballistic missiles for strategic intimidation.

Crisis Response

According to international law, a U.S. warship is sovereign U.S. territory. This simple fact remains constant wherever the vessel operates. A warship operating in international waters is not hampered by many of the political constraints and overflight restrictions that may interfere with ground-based operations or air operations. Normally, ships stationed offshore are not obtrusive; as conflicts erupt, ground based forces, which are very visible may potentially escalate conflicts.[6]

Naval forces are truly expeditionary in nature. Although the other armed services tout this same capability, the fundamental difference is the Navy-Marine Corps performs this function through forward presence instead of continental U.S. based assets. As the U.S. continues to withdraw from overseas bases, naval forces will play a vital role in potential crisis situations. Navy surface combatants normally operate in potential threat areas, or can be rapidly repositioned to crisis areas. These forces are self-sufficient and can remain on station indefinitely.

More than seventy-five percent of the world's land mass is bordered by water. Many of the areas are located where future conflicts are likely to materialize and are within the Navy's capability to project power. The U.S. usually recognizes a 12 nautical mile (nm) territorial sea limit which means that Aegis surface combatants operating in a near land environment can be stationed closer to anticipated TBM launch points or predicted impact points.

Regional Conflict

Naval forces make a vital contribution during the transition from crisis to conflict. Naval forces are designed to support insertion of U.S. and allied forces into the region through friendly ports, coastal airfields or forced entry operations. This also includes protection of vital sealift assets, theater sea lines of communication, and ports or fields of debarkation.[7] Aegis surface combatants can be especially useful during this phase of operations. The mobility of a surface ship makes it a less likely target than a ground based unit during a forced entry. Aegis surface combatants used in this role can provide air defense for the amphibious ready group, support helicopter airborne assaults, conduct fire support missions, launch Tomahawk cruise missiles or provide TBM defense. For example, USS TARAWA was almost hit by an Iraqi Scud missile while in port Al Jubayl during the Gulf War. This incident could have been potentially disastrous considering the amount of ammunition stored on the pier at the time. An Aegis surface combatant, equipped with Navy Area Defense missiles, will be able to prevent this type of attack in the future.[8]

Strategic Lift

Military airlift and sealift has been the subject of much debate since the Persian Gulf War. General Shalikashvili, Chairman Joint Chiefs of Staff, had this to say, "If we do not build a transportation system that can meet our needs tomorrow, then it doesn't matter much what kind of force we have because we won't be able to get it there." The military transportation system is a product of the Cold War. Foreign base closures, extensive lift requirements for expeditionary forces, shrinking defense dollars and aging strategic lift assets are all contributing to the problem.

The Gulf War is an excellent example of the strain that can be placed on the strategic lift infrastructure during a conflict. The first Patriot Battalion was airlifted into theater by day 34. The second Patriot Battalion arrived through a combination of airlift and sealift by day 82. Fifty C-5 sorties were required to airlift the two Patriot Firing Units used in Israel.[9] A Patriot Battalion consists of six fire units, 48 launchers and 192 missiles. It would take 94 C-5 sorties and 19 C-141 sorties to airlift a single Patriot Battalion.[10] This number will increase dramatically if the C-17 becomes the primary airlift asset.

The Navy envisions a notional carrier battle group with six Aegis surface combatants, two cruisers and four destroyers. Each cruiser is capable of carrying 122 missiles and each destroyer, 90 missiles. These six Aegis surface combatants contribute an inventory of 604 missiles that can be tailored to meet theater air defense (TAD), Strike Warfare and TBMD missions.

Past Investment

One of the central themes of the 1993 Department of Defense Bottom-Up Review was acquisition streamlining. The Department of Defense could not continue to invest large sums of money in research and development of new technologies only to procure systems that did not meet the warfighter's needs. Specifically, the report emphasized procurement of commercial products and fielding new systems based on existing technology.

The Navy TBMD program maximizes the use of existing technology and past investments in the Aegis, Standard Missile and command and control (C2) systems infrastructure. The nation has already invested over 40 billion dollars in the production of 22 Aegis cruisers and more than 30 Aegis destroyers. The Standard Missile SM-2 Block

IVA missile used for TBMD is a modified Standard Missile the Navy had already procured for TAD. The various blocks of Standard Missiles have been the Navy's primary surface-to-air weapon for over 30 years and represents a 1 billion dollar investment. Aegis ships have state of the art C2 suites initially designed to support large scale, blue water air wars. The TBMD mission is an extension of the Aegis surface combatant's primary role--air defense. Therefore, there will be no requirement for additional manning, training or logistics to support this mission.[11]

Detection and Tracking

Detection and Tracking Experiment

The Detection and Tracking Experiment represented the Navy's initial attempt at TBMD development. Accomplished in May 1993, the purpose of this experiment was to demonstrate the AWS's ability to support ballistic missile defense. Prior to this experiment, the Navy had participated in several ballistic missile detection and tracking exercises, to support Gulf War claims that several Aegis cruisers had tracked Iraqi Scud missiles. These events provided the foundation for Navy TBMD development. Information was gathered on how to discriminate between the warhead, booster and unintentional debris. These events also helped overcome the SPY radar's transition to track process, since TBMs operate at a speed much higher than the radar was designed.[12]

The data gathered from the earlier tracking events was used to modify both the SPY and C&D computer programs. The SPY program modifications concentrated on increasing overall search range, removing search elevation limitations, and providing more energy for extended range detection. The C&D program modifications provided the

capability to display TBM data and, transmit and receive TBM related information via Link-11. Using the modified computer programs, two Aegis cruisers detected and tracked two targets, Red Tigress I and II, from target launch to target impact. In addition to tracking the targets, each ship was also able to successfully transmit and receive TBM data over Link 11.[13]

Extended Tracking and Control Experiment

The Extended Tracking and Control Experiment (ET&CE) represented the second phase of TBMD development. Conducted in July 1995, this experiment demonstrated the AWS's ability to support multi-ship coordinated TBM operations, and extended range TBM detection and tracking.[14]

Although minor computer modifications had been made in previous tracking events, this was the first time that AWS and some of the support systems were specifically modified to improve TBM detection, tracking and data transfer. C&D and ADS were modified to display TBM track data and the target's predicted flight path. Link-11 messages were modified to accurately transmit and receive TBM track information, which allowed cueing and data transfer between the two ships. Tactical Receive Equipment (TRE) was added to permit remote cues from national level sensors. Track filters were modified to support TBM tracks and the SPY signal processor firmware was modified to correct for range discrepancies created by high speed targets.[15]

Two Aegis cruisers were used to conduct the exercise, one ship was stationed near the launch site and the second ship was stationed in the vicinity of the predicted impact point. Both ships were able to detect and track the target at extended ranges. More importantly, both ships demonstrated the ability to detect and track ballistic missiles using

the SPY radar's autonomous search capability, transmit and receive Link-11 cues from the other ship, and respond to remote cues received from national level sensors.[16]

Non-Tactical Data Collection Patch

The Non-Tactical Data Collection (NTDC) patch is a collection of computer program modifications that allows the AWS to detect, track and display TBM-like vehicles. This feature was developed to gather data on TBM threats. The computer program modifications effect SPY, C&D, and ADS. Collectively, these three patches permit detection and tracking of TBM-like targets, enable data collection and reduction, and provide the ability to display and replay TBM data on the ADS.[17] The usefulness of this feature was demonstrated in March 1996, when the USS BUNKERHILL, outfitted with an NTDC patch, detected, tracked and recorded the launching of four Chinese M-9 ballistic missiles that were fired into the ocean near Taiwan.

Navy Area Defense

The Navy Area Defense Standard Missile SM-2 Block IVA missile is a modified version of the SM-2 Block IV Aegis extended range missile. This latest Standard Missile's roots extend back to the TARTER and TERRIER programs. The Block IVA missile is a vertically launched, booster enhanced, solid-fuel propellant interceptor with a blast fragmentation warhead and a dual mode seeker. This high speed, long range interceptor has been designed as a multi-role weapon capable of engaging cruise missiles, unmanned aerial vehicles, aircraft and lower tier TBMs.[18]

The Block IVA interceptor is a basic Block IV Aegis extended range missile equipped with an imaging infra-red seeker, a forward looking and side looking radio frequency fuze

and an enhanced blast fragmentation warhead. The infra-red seeker provides longer acquisition ranges, decreased homing times and immunity to electronic counter measures.[19]

The Block IVA missiles and prototype warheads have undergone a series of rigorous tests to evaluate missile design performance, optimum fragment size, blast pattern and lethality. The missile flight demonstrations were used to validate critical missile flight functions such as seeker detection and tracking. The warhead tests were initiated based on claims that blast fragmentation warheads were an inferior method of defeating TBMs. Lethality tests were designed to simulate actual flight conditions against realistic conventional, chemical and nuclear targets. These tests resulted in extensive damage to all targets and proved the warhead's capability against high explosive, bulk chemical, nuclear and submunition payloads.[20] The Block IVA missile's TBMD capability was successfully demonstrated by intercepting an Army Lance missile in January 1997.

Navy Theater-Wide Defense

The Navy Theater-Wide Defense missile will be an SM-2 Block IV missile modified to carry a Lightweight Exoatmospheric Projectile (LEAP). The SM-2 LEAP is a four stage missile that incorporates the Block IV's first stage booster and second stage dual thrust rocket motor (DTRM). The third stage is a Global Positioning System (GPS) - aided, inertially guided advanced solid axial stage (ASAS) rocket. The fourth stage is the LEAP kinetic-kill vehicle (KKV).[21]

The SM-2 LEAP uses hit-to-kill technology to destroy inbound threats. The warhead is a small inert mass that physically collides with the inbound TBM. The booster and the

DTRM are used to propel the missile into the exoatmosphere. Initial guidance is provided by the SPY radar. The third and fourth stages exit the atmosphere as an composite unit. A series of thrust vector nozzles located around the ASAS rocket motor are used to make course and attitude changes.[22] The nose cone is ejected and the KKV separates from the third stage. The KKV homes on the infra-red signature of the inbound TBM.[23] Although the mass of the inert warhead is rather small, the physics of the resulting collision is quite destructive.

Testing of the SM-2 LEAP began in 1992. Between 1992 and 1995, the Navy demonstrated that the propulsion and guidance elements, which are identical on both the SM-2 Block IVA and SM-2 LEAP, were capable of achieving the altitude and accuracy necessary to support the upper tier mission. They also demonstrated a successful nose cone separation from the ASAS rocket motor and deployed a KKV-like object into the exoatmosphere. Several of the flight tests in 1995 were conducted using operational LEAP missiles. Most of these events were treated as technology demonstrations rather than a test of a fully functioning LEAP missile. In each test, although an intercept was not achieved, the Navy was able to successfully demonstrate the ASAS rocket motor, the imaging infra-red seeker and the inertial guidance system.[24] Based on a 1996 TMD program level review, the Navy will continue concept development and technology demonstration but will not yet commit to development or production.

Battle Management/Command, Control, Communications, Computers and Intelligence

Battle Management/Command, Control, Communications, Computers and Intelligence (BM/C4I) are the systems used to manage, coordinate and integrate the

various capabilities necessary to conduct passive defense, active defense and attack operations. The development process for the Navy's command and control (C2) architecture has been similar to the Navy Area Defense program and Navy Theater-Wide Defense program development process, maximize use of existing systems, upgrade as necessary, but leverage on the past investment in existing systems and their infrastructure.

The Navy's proposed theater air defense C2 architecture is divided into three broad areas: C2 systems, combat direction and weapon systems, and tactical data links. These three areas, supported by a robust communication infrastructure, will be used to support the Navy's TBMD mission. C2 systems provide intelligence, indications and warnings, and remote cueing. Combat direction systems extend the shooter's horizon, display TBM data, and provide the actual hard kill capability. Tactical data links permit rapid data transfer and remote cueing. Most of this architecture is already in-place, with the exception of the Cooperative Engagement Capability (CEC) portion within the combat direction system area.[25]

The CEC networks geographically dispersed sensors to produce a high quality composite track that is identical at every unit participating in the network. In essence, each ship in the network receives real-time fire control quality data. The use of CEC offers several advantages. First, the CEC concept has a number of inherent performance benefits: increased battle space, improved reaction time, longer intercept ranges and greater depth of fire. Second, track accuracy can be increased significantly by integrating radar measurements from different units taken at different angles from the target. Third, CEC can help maintain track continuity and minimize track masking caused by radar fade zones, multipath, jamming and near land clutter environments. Finally, the fire control

quality shared data base combined with the capability to receive cued engagements and engage on remote data will permit Aegis surface combatants to engage cruise missiles, air craft, and TBMs using another unit's radar data.[26]

Several exercises have demonstrated the viability of CEC in a TBMD role. In 1995, the EISENHOWER Battle Group linked synthetic TBM tracks from the Adriatic Sea to the Army's 32nd Air Defense Command in Germany.[27] Two Aegis cruisers have conducted simulated and live missile firings in exercises such as Development Testing (DT)-IIA, Joint Task Force (JTF)-95 and the All Services Combat Identification Evaluation Team. Based on the results of these exercises, the Navy declared initial operational capability (IOC) in September 1996.[28] The Navy intends to install the CEC system on approximately 200 ships and aircraft, including Aegis cruisers and destroyers, various classes of amphibious ships, and the E-2 Hawkeye aircraft.

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Chapter 5

Conclusions

The post-Cold War era has produced a strategic environment where the threat of global nuclear war has greatly diminished. However, ballistic missiles and WMD have quickly emerged as the new threat to the international community. Even though countries like China continue to expand their nuclear arsenal and Russia still maintains a rather large nuclear arsenal, most western nations have focused their attention on short range TBMs.

Recent intelligence assessments of the global missile threat have determined that more than 30 countries possess some form of ballistic missile. The trend in ballistic missile proliferation continues towards increasing range and lethality. Some would suggest that since ballistic missiles are not the only method of delivering WMD their proliferation is of no consequence. Unfortunately, developing countries are acquiring ballistic missiles for the advantages they offer along with their deterrent and coercive value. For example, history has repeatedly demonstrated, since Hitler's use of the V-2 rocket in WWII, that mobile ballistic missiles are essentially immune to preemptive strikes. Modern missiles possess the lethality of manned aircraft and operate at greater ranges without the massive support infrastructure or risk of lives. Many countries can detect ballistic missile launches, however, they do not possess the active defenses to defeat these missiles. The ease of use,

the limited global defensive capability combined with their cost effectiveness make ballistic missiles a natural political and military weapon.[1]

In March 1996, China fired four unarmed M-9 ballistic missiles into the sea near T'aipei and Kao Hsiung Taiwan. Analysts speculate that these missile firings were a possible attempt to influence the presidential elections taking place in Taiwan. Although this attempt at strategic intimidation failed, according to David Bosdet of the Centre for Defence & International Security Studies, the "Chinese government has set a precedent with this late-twentieth century version of gunboat diplomacy."[2]

In response to China's action, USS BUNKERHILL, equipped with the SPY radar NTDC patch, was quickly repositioned into the area. She was able to detect, track and record data on all four missiles. The Chinese missile firings represented a unique opportunity to demonstrate the operational capability of sea-based TMD against a significant real world threat. First, this event provided the first opportunity for the intelligence community to gather radar data on this particular threat. Second, the observed track data provided further information on how to aid the discrimination process in both the endoatmospheric and exoatmospheric portions of ballistic missile flight. This data may also be used to provide enhancements to the TMD-GBR, which like SPY, is phased array radar. Third, detection and target tracking were accomplished using an older version SPY radar. The modifications installed on the two ships conducting the ET&CE were specifically designed to assist with TBM detection and tracking. These modifications were not installed on the BUNKERHILL. All detections were based on shipboard initiated autonomous search without the aid of cueing from another ship or

national level sensors.[3] This event proved that sea-based TBMD is a necessity and can provide a vital contribution towards countering the TBM threat.

The U.S. Navy has focused on two separate, but complimentary solutions. The near term solution is the Navy Area Defense program. Aegis surface combatants performing the area TBMD mission will be able to protect amphibious objective areas, expeditionary force insertion, embarkation and debarkation ports, coastal air fields and critical military assets from short to medium range TBMs. This system will be deployed initially on two Aegis cruisers in fiscal year 1998 with overall fleet deployment in 2001. The second solution is the Navy Theater-Wide Defense program, which will greatly increase the overall defended footprint and provide sea-based defense-in-depth.

Sea-based defense is a mission enhancer. Naval forces will generally be the first units to arrive in a crisis area. Their inherent mobility and flexibility when combined with a multi-mission Aegis surface combatant, will provide extensive coverage to support air, land and sea operations. Sea-based forces are unobtrusive, are not restricted by foreign basing rights, can remain on station indefinitely, and are not dependent on strategic lift.

The Navy has embarked on a strategy designed to field a robust TMD and TAD capability that is interoperable and cost effective. Development risks and costs are lower because the area and theater-wide defense programs have evolved around proven Aegis and Standard Missile infrastructures, BMDO technologies and a robust BM/C4I architecture. The use of low rate initial production and the philosophy of build-a-little-test-a-little has helped maintain procurement costs at an acceptable level.

Most of the potential flash points in the world, including those areas harboring vital U.S. interests, are in close proximity to coastlines. The Army and Air Force have become

predominantly continental U.S. based expeditionary forces as the number of overseas bases continues to decline. Just as the Navy will not replace the Air Force and the Marine Corps will not replace the Army; sea-based TBMD forces will not replace ground-based TBMD forces. However, the Chinese missile firings did demonstrate the type of scenario where sea-based forces can be very effective. To achieve the defense-in-depth and the extensive defended footprint necessary to support the Joint TMD framework requires the synergistic effect of sea-based and ground-based TBMD forces. Rapidly deployable and maneuverable, TBMD assets are a national necessity. Aegis surface combatants will fill that need.

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Glossary

ADS	Aegis Display System
ASAS	Advanced Solid Axial Stage
ASCEIT	All-Service Combat Evaluation Identification Team
AWS	Aegis Weapon System
BM/C3	Battle Management/Command, Control and Communications
BM/C4I	Battle Management/Command, Control, Communications, Computers and Intelligence
BMDO	Ballistic Missile Defense Organization
BPI	Boost Phase Intercept
CEC	Cooperative Engagement Capability
C2	Command and Control
C4I	Command, Control, Communications, Computers and Intelligence
C&D	Command and Decision
ERINT	Extended Range Interceptor
GEM	Guidance Enhanced Missile
GBR	Ground Based Radar
KKV	Kinetic Kill Vehicle
LEAP	Light-Weight Exoatmospheric Projectile
MEADS	Medium Extended Air Defense System
NTDC	Non-Tactical Data Collection Patch
NTWD	Navy Theater-Wide Defense
PAC	Patriot Advanced Capabilities
SM	Standard Missile
TAD	Theater Air Defense
THAAD	Theater High Altitude Air Defense
TBM	Theater Ballistic Missile

TBMD	Theater Ballistic Missile Defense
TMD	Theater Missile Defense
WCS	Weapon Control System
WMD	Weapons of Mass Destruction
WWII	

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